TE MANATŪ WAKA
MINISTRY OF TRANSPORT

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Section	Description of ground
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9(2)(h)	to maintain legal professional privilege
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9(2)(j)	to enable a Minister of the Crown or any public service agency or organisation holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations)

Carbon Methodology, Results and Opportunities

Draft P02

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1. Introduction

One of the three investment objectives of the Auckland Light Rail (The Project) corridor business case (CBC) is to deliver a transport intervention that reduces Auckland's carbon emissions. Demonstrating that the investment objectives are met is a key requirement for the CBC.

Reducing Auckland's GHG emissions is part of mana whenua's wider aspirations for climate action as outlined in Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan and in Te Ora ō Tāmaki Makaurau Wellbeing Framework. Where emission reductions and the "shift from a carbon dependent city and region" are identified as Ngā Ara Whakaahua Matua: Transformational priority pathways for Tāmaki Makaurau.

As such, greenhouse gas (GHG) emission estimates are required to supplement the Economic Case and form part of the case for change.

The purpose of this appendix is predominantly to provide a summary of the ALR Carbon Methodology that was developed to assess the whole-of-life (WL) GHG emissions on The Project. The methodology used prescribes a consistent way of carrying out impact assessments that can be used across all options and scenarios being tested within the Corridor Business Case (CBC).

The methodology is intended to meet the requirements PAS2080:2023[1] Section 7 "Whole life carbon assessment principles to support decision-making". A summary of the assessment results for project options (namely the Emerging Preferred Option (EPO) and Intermediate Comparator (IC)) under various urban and transport growth scenarios is also provided.

Emissions reduction opportunities have been assessed against the ALR Carbon Methodology for their effectiveness in The Project's context, and for their feasibility for delivery. This appendix provides some further narrative on the opportunities quantified. Assessment results for each option and scenario feed directly into the Economic Case.

Note that the terms 'carbon' and 'GHG emissions' are used interchangeably throughout this document. Both terms are used in reference to climate change causing greenhouse gases that are directly or indirectly emitted as a result of The Project's activities.

[1] Carbon management in buildings and infrastructure

2. Methodology

2.1 Methodology overview

The purpose of this section is to present a summary of the ALR Carbon Methodology used to assess the WL GHG emissions of transport options for The Project, the results of which are presented in the Economic Case. It provides requirements for how GHG emission assessments are calculated and provides justification for methodological elements.

The Project has aligned the design and GHG emissions management process with the PAS 2080 standard[2] for GHG emissions management. PAS 2080 provides a 'systems thinking' framework to guide GHG emissions reduction projects and alignment of projects, developments and systems with targets for net zero emissions by 2050[3].

As PAS2080 recognises a 'systems thinking' approach to GHG emissions management, the ALR Carbon Methodology seeks to assess GHG emissions from the whole system that The Project will operate in. That is, the GHG emissions it will directly control (such as those related to construction and operation of The Project assets) and the GHG emissions related to the system that it can influence (such as those related to the emissions associated with the users of The Project assets and the value chain delivering The Project).

2.2 Assessment Standards

PAS 2080 requires GHG emissions assessments against "...lifecycle analysis standards and /or other recognised sources..."[4]. The ALR Carbon Methodology assesses operational and embodied emissions related to the construction and use phase against EN 17472[5]. Enabled emissions are assessed using a bespoke methodology, guided by the principles of PAS2080. The assessment follows Treasury's Better Business Case Guidance where applicable. Figure 1 describes how these assessment standards and datasets combine to produce set of comparable emissions for use in The Economic Case. Detail on datasets can be found in Section 2.7.

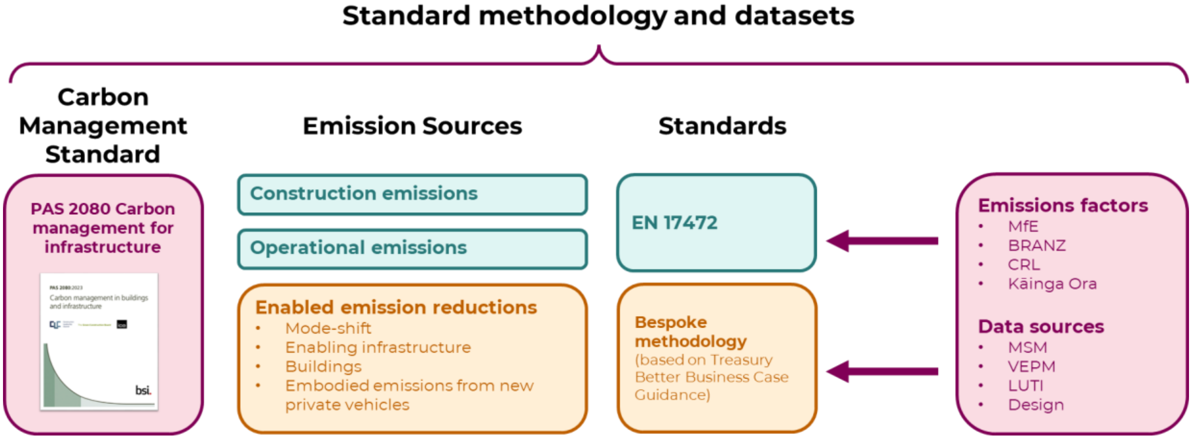

Figure 1: Carbon assessment standards and data sources

[2] PAS 2080:2023 "Carbon Management in Buildings and Infrastructure"
[3] This includes Clauses 0.1, 4.2 and 8.2.1 in PAS 2080 and net zero targets in the Climate Change Response (Zero Carbon) Amendment Act 2019 and Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan
[4] Clause 7.1.3a
[5] EN 17472:2022, "Sustainability of construction works. Sustainability assessment of civil engineering works. Calculation methods"

2.3 Scope of GHG Emissions Assessment

2.3.1 Options

For the purposes of the Economic Case, the GHG assessment has been focussed on presenting WL GHG emissions from several scenarios related to options and urban growth. Three options were considered as part of a wider array of scenarios to feed into the Economic Case:

Do minimum: This is what would happen without The Project being built. It is assumed that population growth would continue, and existing car-oriented traffic and residential development would continue. GHG emissions calculated for this scenario are predominantly produced from continuing road transport emissions.

Emerging Preferred Option (EPO): The EPO is a part tunnelled metro system. GHG emissions calculated for this scenario are from the embodied emissions of manufacturing and constructing the metro system assets, operating those assets and the change in transport related GHG emissions predicted as a result of transport modal shift onto the new transport system.

Intermediate Comparator (IC): The IC is a surface running light rail system. GHG emissions calculated for this scenario are from the embodied emissions of manufacturing and constructing the metro system assets, operating those assets and the change in transport related GHG emissions predicted as a result of transport modal shift onto the new transport system.

Scenarios are made up of a combination of the above options, using Macro Strategic Model (MSM) runs to calculate enabled transport, and Land Use and Transport Interaction (LUTI) modelling to calculate urban emissions. GHG emissions for each scenario are calculated as the difference between the do-minimum scenario and the scenario being assessed.

Information on these scenarios is presented in Table 1.

Table 1 Scenarios assessed for the Economic Case

Scenario	Alignment option	Description
Emerging preferred option (EPO)	EPO	Baseline scenario for the EPO under standard urban growth conditions.
EPO – Incremental Investment (EPO – II)	EPO	Baseline scenario for the EPO. High levels of urban densification around the stations for the EPO, leading to more modal shift from onto the new transport system
EPO – Active Investment (EPO-AI)	EPO	Baseline scenario for the EPO. Very high levels of urban densification around the stations for the EPO, leading to more modal shift from onto the new transport system
Intermediate comparator (IC)	IC	Baseline scenario for the IC under standard urban growth conditions

2.3.2 System boundaries

Two key boundaries were defined to make up the system boundaries that define the scope of emission sources for the GHG emissions assessments:

Project boundaries: contains emission sources directly attributable to the construction and operation of The Project e.g. materials and fuel consumed during construction of stations, operational energy use.

Study boundaries: contains emission sources indirectly influenced by the introduction of an intervention, e.g. avoided emissions resulting mode shift from private vehicles to a lower emission option.

Figure 2 presents the generalised emission sources in scope of the assessment. Note that end of life and maintenance processes were not assessed for the purposes of this business case.

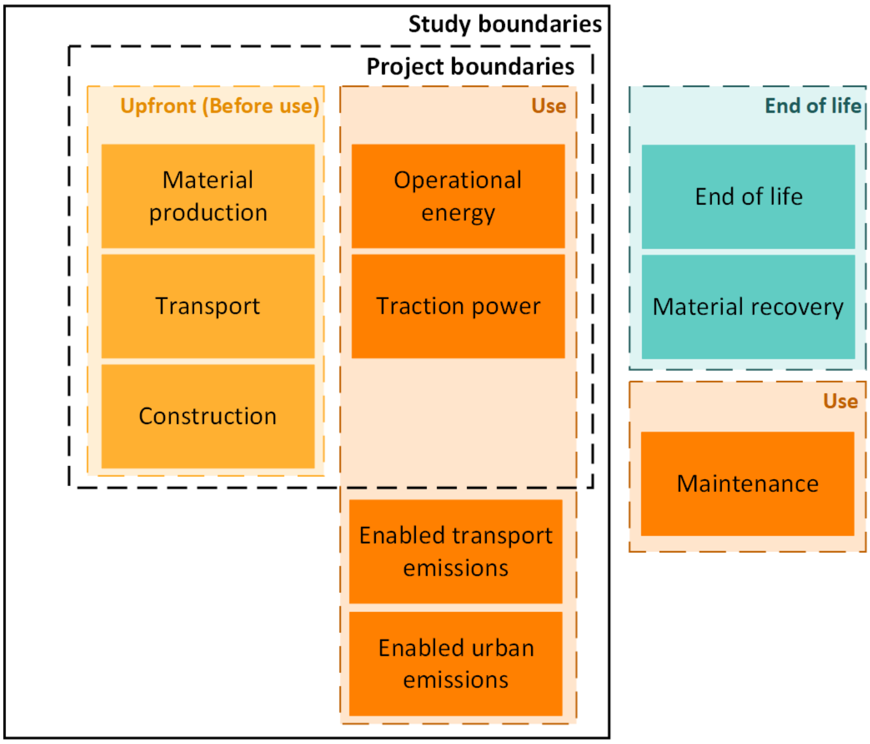

Figure 2: System boundaries for the GHG emissions assessment

2.3.3 Embodied and Operational GHG emissions

Embodied and operational GHG emissions are emissions relation to the material production, transport, construction, and operation of The Project. They sit within the Project boundaries as presented in Figure 2. Embodied and operational GHG emission sources include:

- Rail infrastructure, including tunnels, viaducts, and trenches
- Stations
- Traction power system
- Ventilation shafts
- Rail depot
- Rolling stock (added incrementally to the network to match demand)
- Utilities
- Emissions from providing electricity to operate The Project assets.

2.3.4 Enabled GHG Emissions – Transport

The Project is expected to reduce transport GHG emissions for the city, by shifting people to lower carbon modes of transport and reducing trip distances. Changes to the GHG emissions of the transport system are through the addition of the option, changes to the bus network to support the option, and land use change (densification around stations) expected because of transport investment.

The following sources of enabled transport emissions are included in ALR's whole of life greenhouse gas (GHG) emissions:

- Light vehicle and heavy vehicle tailpipe emissions
- Generation and transmission of electricity for electric vehicles
- Embodied emissions from manufacturing private vehicles

The following enabled transport emission reductions are incorporated:

- Investment in light rail (modelled)
- Land use intensification (modelled)
- Congestion pricing and parking pricing in the city centre (modelled as part of The Project Do-Min and Do-Something scenarios)
- Working from home (modelled as part of The Project Do-Min and Do-Something scenarios)
- Reduced car ownership (out-of-model estimate)
- Active mode improvements around stations (out-of-model estimate)
- Traffic reduction measures around stations (out-of-model estimate)

2.3.5 Enabled GHG emissions – Urban

The Project will change the distribution of population growth across Auckland, with more growth projected to occur within the corridor, and less in other areas of the region (including, but not exclusively, greenfield areas). This assessment compares the GHG emissions from constructing enabling infrastructure (roads, pipes, utilities etc) and residential buildings in the Do Minimum land use scenario with those in project land use scenarios.

Enabled GHG emission reductions from urban and transport sources are correlated to urban development. An increase in urban development along the corridor may provide a GHG emissions reduction from construction and operation compared to do-minimum growth. This growth also supports increased patronage, which has downstream emissions benefits from mode shift and reduced vehicle ownership. The relationship between urban development and enabled emissions is presented in Figure 3.

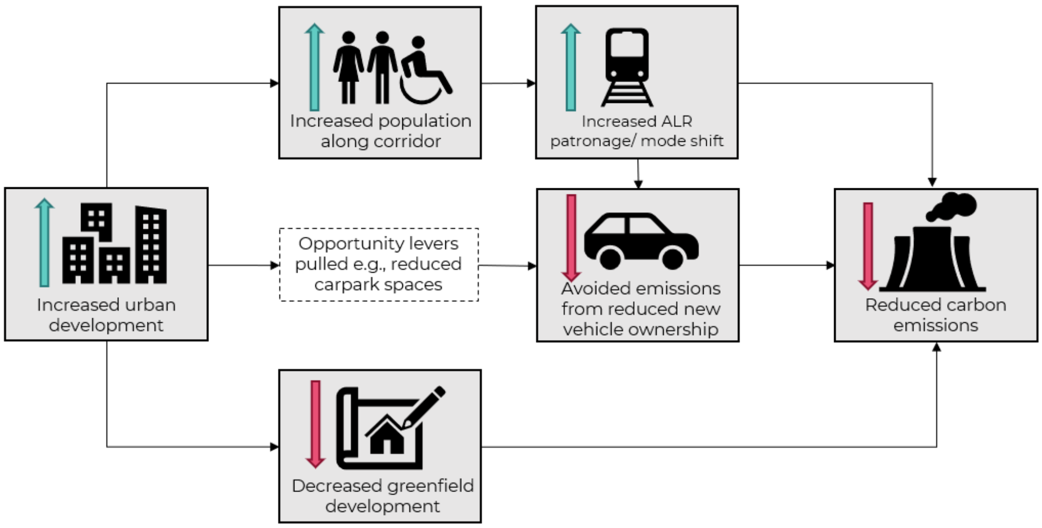

Figure 3 Relationship between urban development and GHG emissions

2.3.6 Reference study period

The reference study period runs from the assumed start date of construction through to 2100 to align with the Corridor Business Case. Key temporal boundaries related the GHG emission impact assessments carried out for each option are presented in Table 2.

Table 2 Reference study periods per option

Alignment option	Construction start	Construction end	Use phase start	Use phase end
EPO	2026	2032 (stage 1)	2033 (stage 1)	2100
IC	2028	2034 (full alignment)	2035 (full alignment)	2100

PAS2080 requires context around meeting Net Zero 2050 goals. In some cases, such as for assessing the emissions reduction potential of opportunities in Section 4, cumulative emissions are measured to 2050, rather than for the full study period to 2100.

2.4 Assumptions

Key assumptions for the assessment of *baseline scenarios* include, but are not limited to:

- Reinforcing steel rate of 150kg/m^3 is assumed for all structural concrete structures, unless otherwise specified in design.
- All concrete, insitu or precast, uses standard concrete using general purpose (GP) cement.
- All reinforcing steel is sourced domestically.
- All operational energy is supplied as 100% renewable electricity.
- End of life of the asset occurs after 2100 (the end of the reference study period) so has not been considered in results.
- Replacement and refurbishment of assets has been estimated under the assumption that an additional 5% of the initial embodied carbon investment of construction is required every 30 years past opening year.

- Maintenance is not considered in the assessment. It is acknowledged that maintenance will provide notable impact, but at this stage of design, is difficult to predict, and model with acceptable accuracy.
- New residential buildings within the corridor are assumed to be built to an assumed business-as-usual standard (i.e. an apartment built along the corridor results in a similar amount of carbon emissions as apartments elsewhere in Auckland for a particular year).
- Construction and operation of enabling infrastructure for new developments (including three waters and electricity is assumed to be built to a business-as-usual standard.

2.5 Emissions Sources Not Assessed

Emissions sources not considered in this assessment include:

- GHG emissions related to the end of life of rail infrastructure given that these emissions are likely to fall outside of the reference study period for the Economic Case (i.e. present – 2100).
- Impacts on existing infrastructure and buildings that can't be quantified at this stage of the design process (e.g. noise and vibration mitigation, environmental impact mitigation, relocation of some infrastructure).
- Carbon removals associated with The Project. This includes carbon removals related to climate resilience measures (e.g. engineered wetlands for stormwater detention), trees planted or marine carbon sequestration initiatives within the corridor.

2.6 Risk and Contingency

Risk and contingency allowances have been made within the GHG quantification. These allowances have been aligned with cost estimating best practice, where appropriate. This is because the practice of cost estimating is a well-developed practice and has some useful corollaries for estimating emissions from infrastructure development.

2.7 Data Sources

Data for the calculation of the ALR GHG emissions is broadly broken down into:

1. material volumes for calculating embodied emissions
2. emission factors
3. forecast operational electricity use
4. transport demand and urban growth modelling

Material volumes are sourced and calculated from design documentation from The Project. Where material volumes are not available, proxies are used which are sourced from other relevant projects.

Emissions factors are mostly from partner organisations and/or public sources including Manatū Mō Te Taiao and BRANZ. Emissions factors for building typologies above three stories and for electricity emissions related to 100% renewable electricity supply (via PPA) have been developed for The Project using publicly available data and modelling tools.

Operational emissions are assumed to be exclusively related to electricity use. Proxies for station energy use from similar projects, along with rolling stock electricity estimates from preliminary modelling, have been used to estimate operational energy use.

Transport demand and urban growth models are used to support the business case for ALR. The carbon assessment also uses these numbers to assign a carbon impact to expected changes in transport demand (including demand for and use of different modes) and urban growth and the expected type of that urban growth.

Key data sources used to carry out the assessment are summarised in Table 3.

Table 3 Key data sources and emission factors

Modelling constituent	Source (s)
Materials	Various EPDs[6], GaBi databases, AusLCI databases, BRANZ CO2nstruct
Construction	PEET tool 3.0, City Rail Link
Transport	Manatū Mō Te Taiao Emissions Factor Workbook
Operational energy	GaBi databases
Fuel rates	Vehicle Emissions Prediction Model (VEPM)
Transport network modelling	Macro Strategic Modelling (MSM) outputs
Urban network modelling	Land Use and Transport Interaction (LUTI) outputs

[6] Environmental product declarations verified under EPD Australasia or EPD International

3. Results

3.1 Emerging Preferred Option

3.1.1 Embodied and operational emissions

Using the ALR Carbon Methodology summarised in Section 0, the total embodied GHG emissions for ALR have been calculated to be approximately 2,100 kt CO_2e for the reference study period.

Operational GHG emissions have been calculated to be circa 58 ktCO_2e for the reference study period, from 2032 - 2100, on the assumptions of a 257 MWh per day electrical load, consistent with the CBC, and a 100% renewable electricity supply.

Note that these results are relevant to all EPO scenarios as in this case, the urban growth scenario investigated does not influence the embodied or operational GHG emissions of The Project's assets themselves.

3.1.2 Enabled emissions savings

The cumulative enabled GHG emission saving estimates, from opening year to 2050, for the EPO under all urban growth scenarios, are presented in Figure 4. These results indicate that increased urban growth unlocks GHG emission savings in all three criteria: mode shift, building and enabling infrastructure, and avoided embodied emissions from new vehicles.

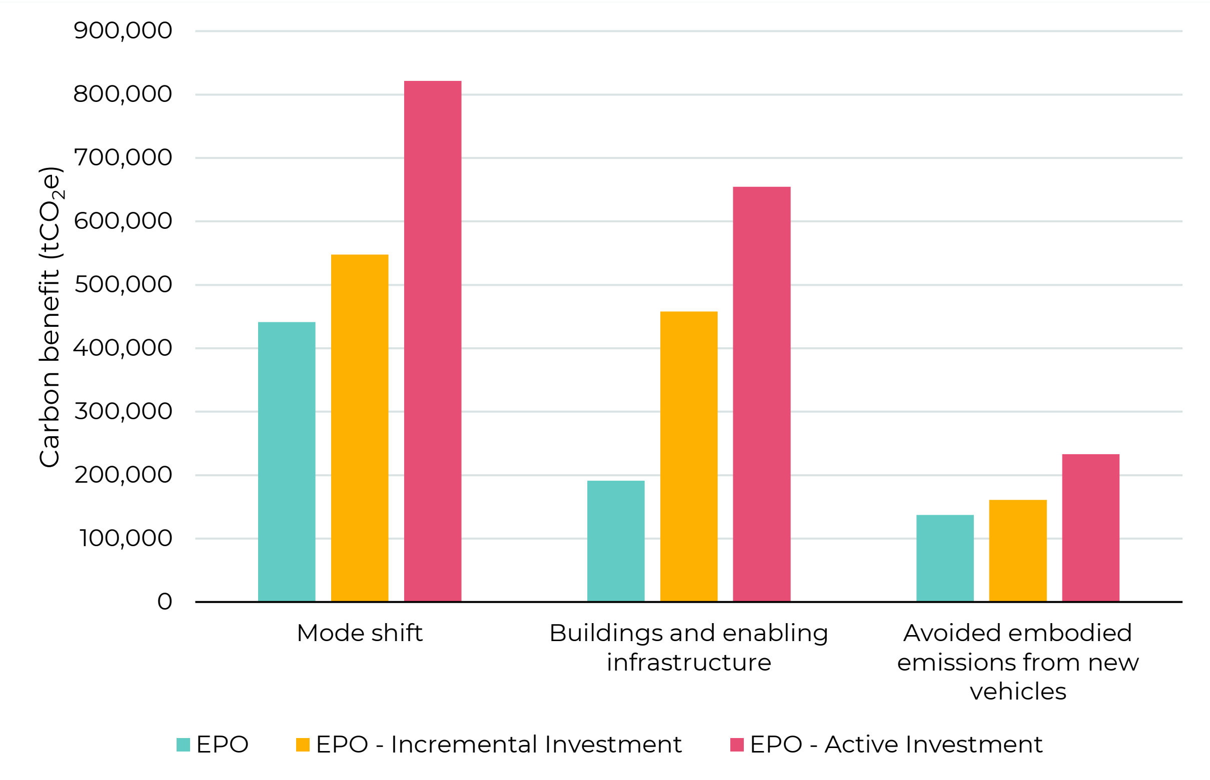

Figure 4 Cumulative Enabled GHG Emission Savings from opening to 2050 – All EPO scenarios

3.1.3 Cumulative Total Emissions - EPO

Figure 5 summarises the WL GHG emissions from start of construction till 2100 for the three EPO scenarios.

Mode shift savings are not linear over time due to the decarbonisation of the grid and the predictions of more people switching over to electric vehicles. All scenarios assume that there is an increase in population of different rates, for the three scenarios. The ALR CBC covers each scenario in more detail.

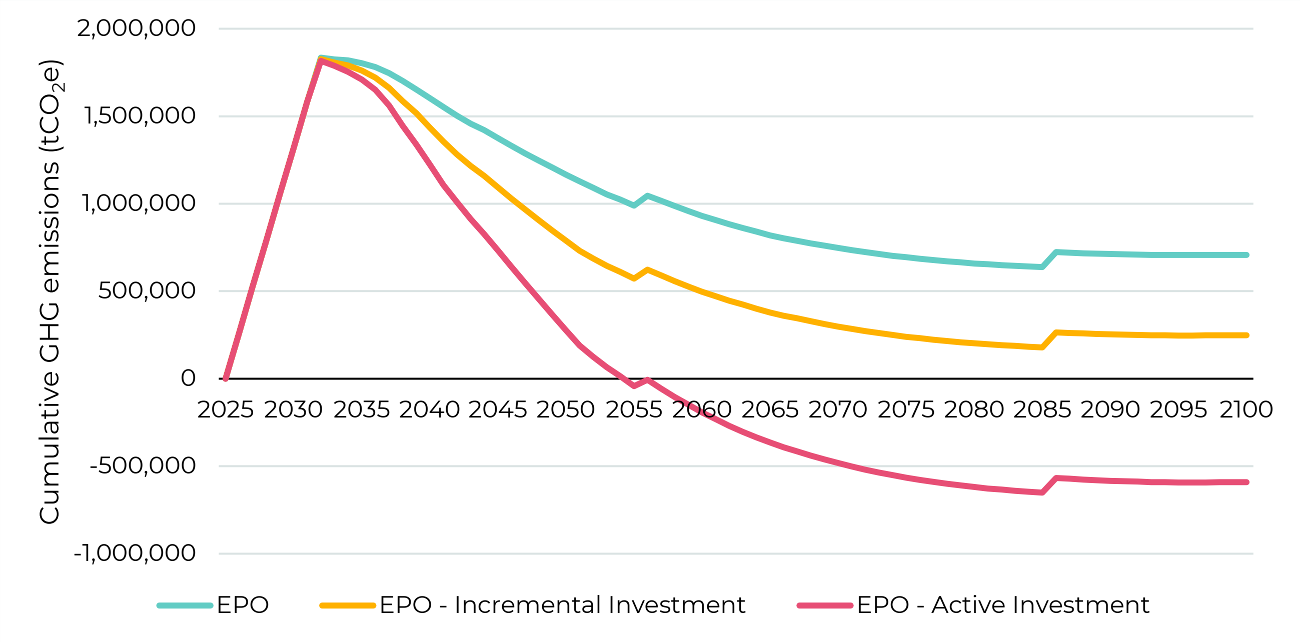

Figure 5 Whole Life GHG emissions up to 2100

3.2 Intermediate Comparator

3.2.1 Embodied and Operational Emissions

Using the ALR Carbon Methodology summarised in Section 0, the total embodied GHG emissions for the IC have been calculated to be approximately 800 kt CO_2e for the reference study period.

3.2.2 Enabled Emissions

As with the EPO, IC enabled emissions have been assessed for mode shift, building and enabling infrastructure, and avoided embodied emissions from new vehicles. A breakdown of cumulative savings by 2050 is presented in Figure 6.

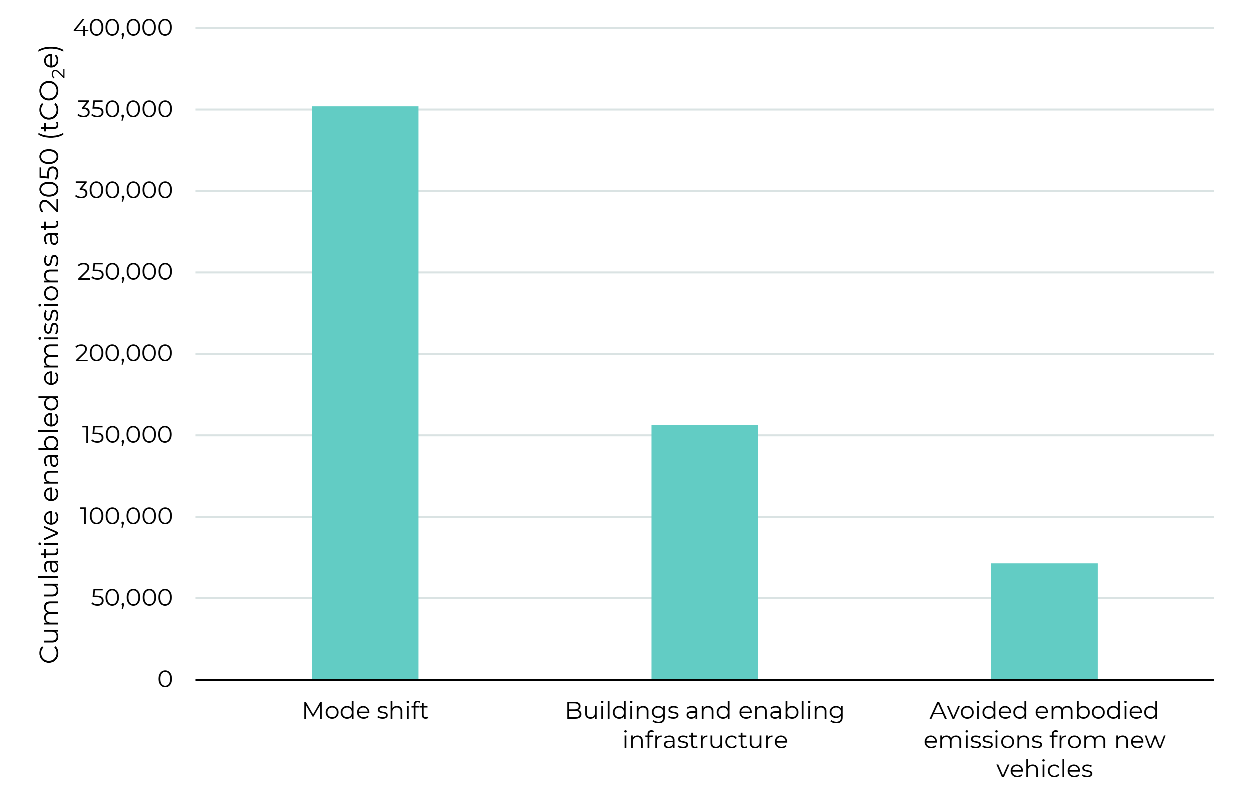

Figure 6 Total Enabled GHG Emission Savings at 2050 – IC

3.3 Results interpretation

Carbon payback curves for the scenarios presented earlier are illustrated in Figure 7. The results indicate that carbon payback, with significant long-term cumulative GHG emission savings, are possible with the EPO, when coupled with high urban growth along the corridor. It is noted that there are risks to achieving carbon payback without enabling such urban growth.

It is acknowledged that further emission reduction opportunities are possible to both reduce the upfront embodied carbon associated with construction and to increase enabled WL GHG savings. These opportunities are explored in section 4. Infrastructure projects require an extensive carbon investment in order to realise their objectives. ALR allows growth to occur in Auckland whilst preparing the city for a low emission, functional future.

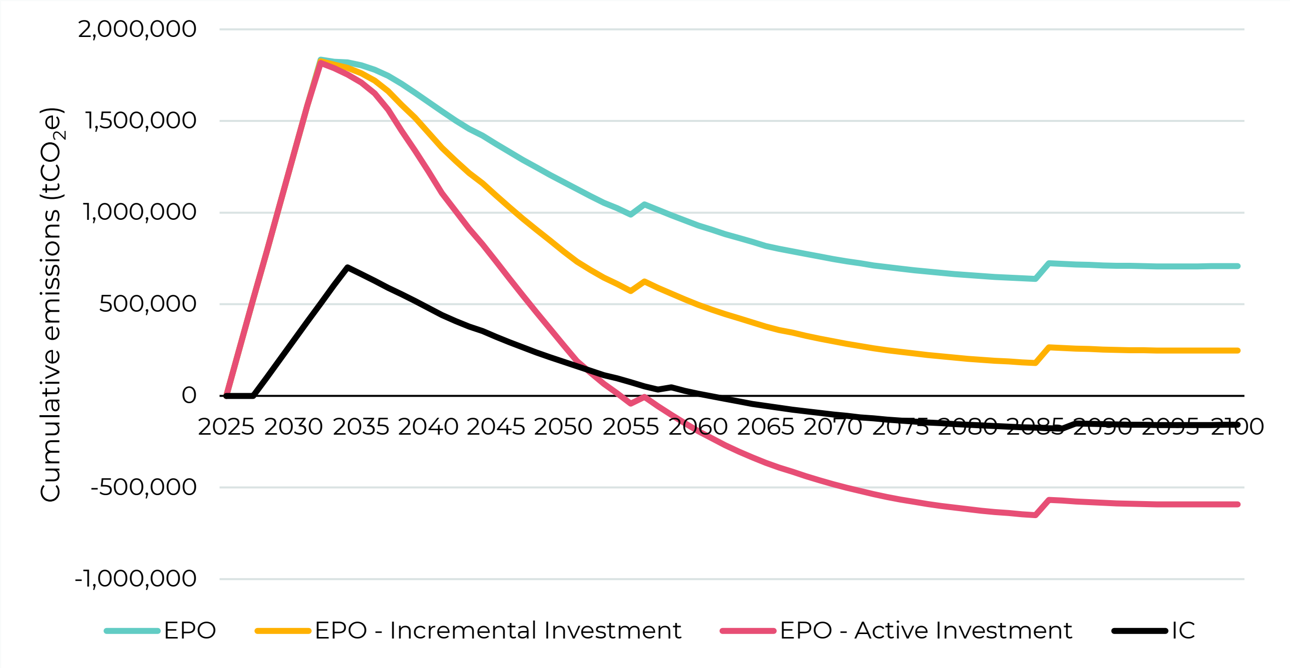

Figure 7 GHG Emissions Scenarios for ALR

3.4 Disclaimers

Results have been assembled based on the best information available at the time of writing. Auckland's urban and transport networks are complex, as are their relationship with GHG emissions that are directly or indirectly emitted or prevented as a result of a transport intervention. Hence, uncertainties and errors are unavoidable. Realised outcomes for The Project will inevitably be dictated by national investments in both The Project and the wider infrastructure sector as the Auckland region[7] and New Zealand strives to meet Net Zero Carbon commitments[8].

[7] Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan
[8] Climate Change Response (Zero Carbon) Amendment Act 2019

4. Carbon Opportunities

Opportunities to reduce whole life GHG emissions have been considered throughout the Corridor Business Case phase, in alignment with PAS 2080. This section discusses quantified opportunities for GHG emissions reductions that are additional to the savings realised through the design process.

This section discusses opportunity identification, the broad principles and parameters of the opportunities, the GHG emission reduction potential for the Economic Case of The Project and touches on the viability and challenges of their implementation.

4.1 Opportunity identification

PAS2080 requires consideration of the implications of The Project on GHG emissions of the wider system, namely Auckland's urban environment and transport network. This means opportunities that sit outside the direct control of ALR are also required to be considered.

For purposes of the CBC, opportunities identified in this appendix are related to material procurement and wider system enabled emissions reductions only. Further reduction opportunities that are realised through value management of the design process sit outside the scope of 'opportunities' assessment but are acknowledged to still play a notable role in emission reduction pathways. Value management was incorporated into the multicriteria analysis (MCA) process carried out to guide decision making for the CBC.

Opportunities were selected for assessment based on high level consideration of their potential to reduce emissions, cost implications, ease of quantification and feasibility of the opportunity.

Other opportunities for GHG emission reduction have been identified, both through the design process and by mana whenua, however the level of information available, at this stage of the design process, does not allow for their assessment. Ongoing engagement within ALR and with mana whenua is expected to identify further opportunities as the design progresses.

4.2 Embodied Emissions Opportunities

4.2.1 Material Substitution: Concrete

Supplementary cementitious materials (SCMs) for concrete were investigated for their potential to reduce the embodied GHG emissions of The Project during construction.

Given the size and scale of the works involved with The Project, New Zealand has an opportunity to influence supply chains by creating demand for current and emerging SCM materials. The level of replacement of SCMs will be influenced by early discussions with suppliers and stakeholders, concrete performance (durability and early strength gain), the construction lead time and the market cost of these products. It may be that certain elements of ALR may be suited to different cementitious replacements.

This opportunity investigates the GHG emission benefit of using a complete replacement of standard concrete (as per Section 2.4) with a 35% PFA concrete mix (from BRANZ CO2nstruct[9]). GHG emission benefit estimates for a full concrete replacement are presented

[9] CO_2NSTRUCT | BRANZ

in Table 4 for the EPO and IC. It is important to note that achieving full concrete replacement could be challenging given the associated cost premium and constraints on supply.

Table 4 GHG emission savings for a 35% PFA concrete mix material substitution

Option	% concrete replacement	Emissions saving potential ($ktCO_2e$)
EPO	100	127
IC	100	43

4.2.2 Material Substitution: Steel

Steel procurement was investigated for its potential to reduce the embodied GHG emissions of The Project during construction.

The New Zealand government, New Zealand Steel, and Contact Energy announced a partnership in 2023 to install an electric arc furnace (EAF) at Glenbrook Steel Mill. Use of an EAF allows for secondary (scrap) steel to be used as feedstock, lowering the steel's GHG emissions intensity by almost 50%[10]. This planned technology change has been incorporated into GHG emissions estimates to adjust the GHG emission intensity of locally sourced steel (as per Section 2.4). However, even with this EAF saving, GHG emissions of steel in New Zealand are still higher than the global average. There remains an opportunity for lower carbon steel, that uses higher proportions of secondary steel and/or uses higher proportions of renewable electricity during processing, to be procured. This may be realised by either overseas procurement or making further advances to local steel production.

An opportunity has been modelled that investigates a 30% replacement of locally procured reinforcing steel with a 100% recycled steel product, produced from 100% renewable energy. Emissions savings for this opportunity are presented in Table 5.

Table 5 GHG emission savings for a 30% replacement of local reinforcing steel with low carbon steel

Option	% steel replacement	Emissions saving potential ($ktCO_2e$)
EPO	30	233
IC	30	61

The actual percentage of low carbon steel that can be used on the project will be influenced by early discussions with suppliers/contractors, steel availability, and the continued reduction in GHG emissions from domestic steel production. It is also acknowledged that procuring steel from outside the region may have additional affects and complications on lead-time, project specification compliance, construction and programme which would need to be reviewed and mitigated.

4.3 Enabled Emissions Opportunities

[10] https://www.nzsteel.co.nz/news-and-media/electric-arc-furnace-announcement/

4.3.1 Low Carbon Residential Building and Enabling Infrastructure

Residential Building

Opportunities exist to reduce emissions associated with the construction and operation of new residential buildings constructed within ALRs corridor, and in the future these are likely to be required by building standards.

An opportunity for emission reduction by reducing carbon associated with residential buildings was assessed. The opportunity focused on three areas:

- **Substitution of cross laminated timber (CLT):** emissions savings are applied on 25% of a building, to reflect that it may not be feasible (and/or it may be too costly) to build high density using CLT universally, and substitution will only be able to be made in places. A further third of savings are taken for the Project, assuming that not all developments will be low carbon.
- **Substitution of low carbon concrete:** emissions savings are applied on 40% of a building, to reflect that it may not be feasible or will be costly, and substitution will only be able to be made in places. A further third of savings are taken for the Project, assuming that not all developments will be low carbon.
- **Low energy apartments:** carbon emissions savings are applied on 75% of a building, while initiatives are only be applied for 33% of developments.

Results suggest that for the EPO-AI scenario approximately **195 ktCO_2e** could be saved over the full reference study period.

Enabling Infrastructure

Opportunities exist to reduce emissions associated with the construction and operation of enabling infrastructure (including three waters and electricity but excluding transport along the corridor). As with residential buildings, enabling infrastructure emissions from new developments in the corridor can reduced using initiatives such as:

- using low carbon materials for construction,
- using low emission construction activities (such as using efficient construction equipment and recycling/reuse),
- reducing the volume of materials required (such as through demand management measures or value engineering).

This opportunity assumes a reduction in emissions to the same extent modelled by project partner research on a low carbon neighbourhood, which explored the impact of the initiatives listed above. Results suggest that for the EPO-AI scenario approximately **29 ktCO_2e** could be saved over the full reference study period.

4.3.2 Increased Mode Shift and Avoided Emissions from New Vehicles

Mode Shift

ALR is expected to increase walking and cycling along the corridor through improving infrastructure for walking and cycling, enabling density and through urban development more generally. This opportunity is based on international research that suggests these actions can shift transport away from private vehicles to a greater extent than that modelled, by reducing vehicle ownership well below Auckland's average. This will reduce tailpipe emissions from private vehicles. This opportunity is reliant on investment in walking and cycling infrastructure and urban development within the corridor.

Results indicate that for the EPO-AI scenario approximately **360 ktCO_2e** could be saved over the full reference study period.

Avoided Emissions from New Vehicles

With urban development along the corridor reducing demand for local private vehicle travel, it is expected that private vehicle ownership rates per household will reduce. This opportunity is reliant on residents with the ALR corridor reducing car ownership in response to a reduced demand for travel. It is expected that developments constructed along the corridor will have a reduced provision of carparking, given this will increase profitability for developers.

Results indicate that for the EPO-AI scenario approximately **170 ktCO_2e** could be saved over the full reference study period.

4.4 Summary of Opportunities

4.4.1 EPO opportunities

The cumulative GHG emission reduction benefits of all opportunities discussed in sections 4.2 and 4.3 are shown in Figure 8. The assessment of opportunities highlights the range of outcomes possible with investment in ALR. By focusing on key actions to reduce carbon emissions (such as encouraging urban development along the corridor), the EPO will be able to achieve substantial reductions in carbon emissions over the option's lifetime.

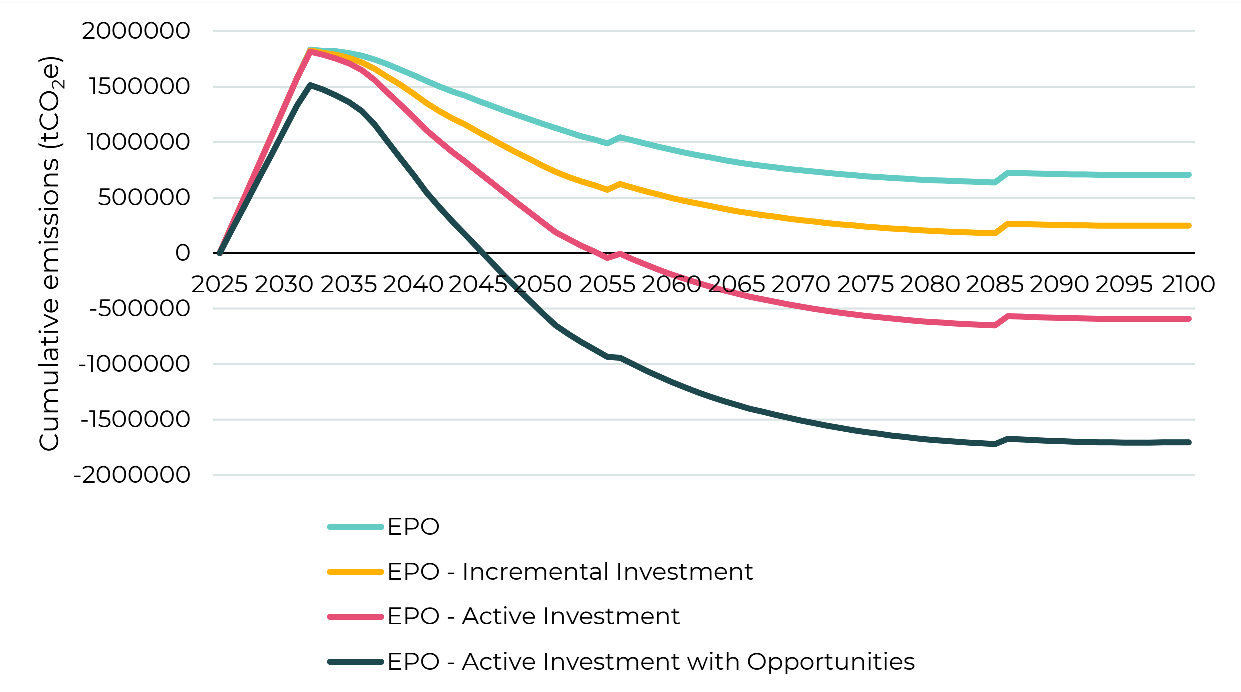

Figure 8 Whole Life Cumulative GHG Emissions – EPO Opportunity Scenarios

4.4.2 IC Opportunities

Cumulative GHG emissions enabled by the IC with and without opportunities are shown in Figure 9. Note that opportunities for the IC option are limited to materials only. Further urban interventions (and therefore urban opportunities) are not being considered for the IC as part of the CBC beyond the transport investment.

The embodied carbon opportunities detailed in section 4.2 have less of an impact on the IC than the EPO. This is because the proportion of the ICs embodied GHG emissions from steel and concrete is lower due to the absence of underground stations.

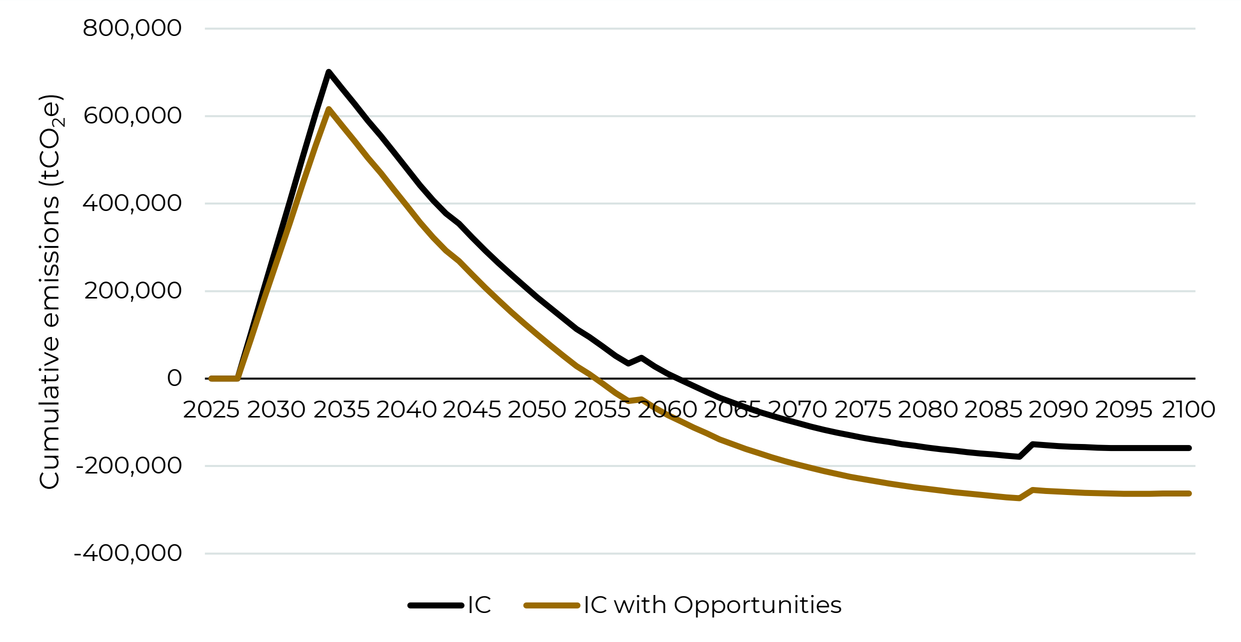

Figure 9 Whole Life Cumulative GHG Emissions – IC Opportunity Scenarios

4.4.3 Options Comparison

Figure 10 compares the cumulative emissions of the EPO including emissions reduction opportunities with the EPO. Enabled emission reductions are lower due to lower patronage of the IC, and lower potential for urban development given the system lacks capacity for greater levels of patronage.

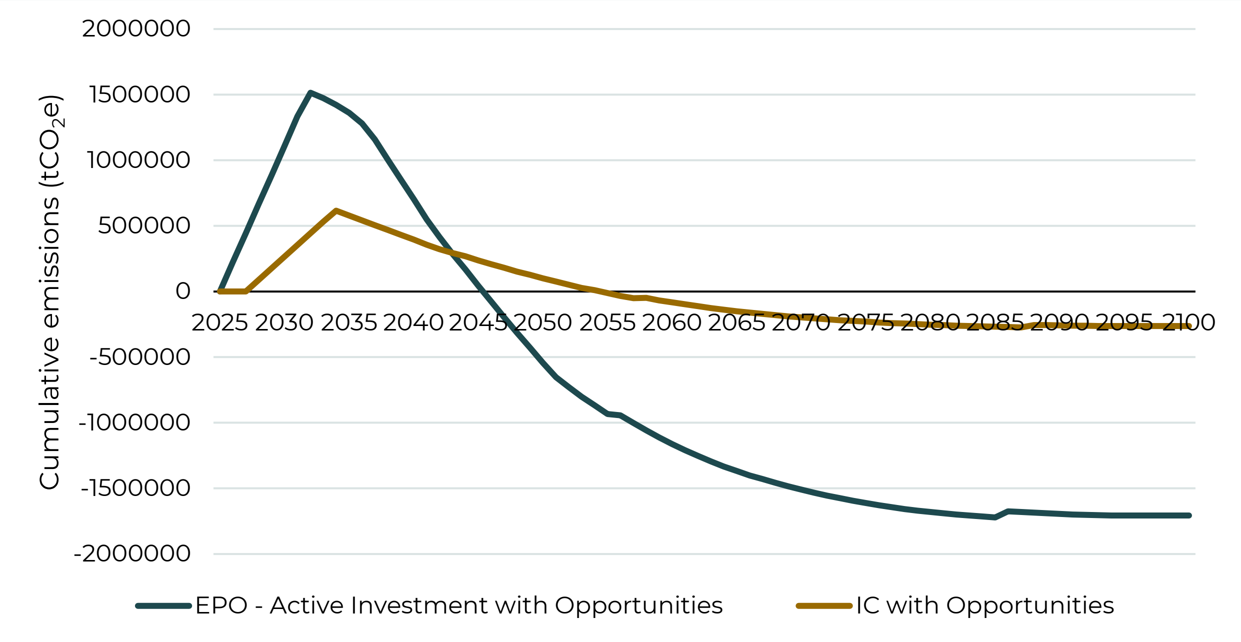

Figure 10 Whole Life Cumulative GHG Emissions – EPO vs. IC Opportunity Scenarios

4.5 Emission reduction opportunities to be explored further

As the design and engagement with mana whenua progresses, further opportunities for emission reductions can be explored and quantified. These include, but are not limited to:

- Opportunities for design refinement (noting there is a large potential for reductions in carbon emissions from design refinement)
- Opportunities for resource recovery and re-use within The Project
- Opportunities for improved energy efficiency
- Use of structural timber
- Carbon removals including but not limited to nature-based solutions within the corridor, as a result of The Project.